(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 509 537 A2**

EUROPEAN PATENT APPLICATION

(21) Application number: 92106688.2

(51) Int. Cl.5: G08B 13/186

(22) Date of filing: 16.04.92

(30) Priority: 16.04.91 JP 84151/91
07.04.92 JP 84294/92

(43) Date of publication of application:
21.10.92 Bulletin 92/43

(84) Designated Contracting States:
DE GB

(71) Applicant: SUMITOMO ELECTRIC INDUSTRIES, LTD.
5-33, Kitahama 4-chome, Chuo-ku
Osaka-shi, Osaka 541(JP)
Applicant: MATSUSHITA ELECTRIC WORKS, LTD.
1048, Oaza-Kadoma
Kadoma-shi Osaka 571(JP)

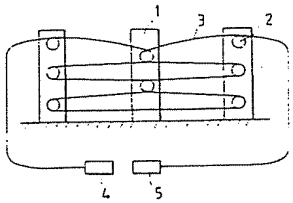
(72) Inventor: Ohta, Junichi, c/o Yokohama Works of Sumitomo
Electric Industries, Limited, 1, Taya-cho
Sakae-ku, Yokohama-shi, Kanagawa(JP)
Inventor: Wakami, Toshinori, c/o Yokohama Works of Sumitomo
Electric Industries, Limited, 1, Taya-cho
Sakae-ku, Yokohama-shi, Kanagawa(JP)
Inventor: Okamoto, Kazuhiro, c/o Yokohama Works of Sumitomo
Electric Industries, Limited, 1, Taya-cho
Sakae-ku, Yokohama-shi, Kanagawa(JP)
Inventor: Miki, Ryusuke, c/o Matsuhita Electric Works Ltd.
1048, Oaza Kadoma
Kadoma-shi, Osaka(JP)
Inventor: Kanbe, Yoshiaki, c/o Matsuhita Electric Works Ltd.
1048, Oaza Kadoma
Kadoma-shi, Osaka(JP)

(74) Representative: Patentanwälte Grünecker, Kinkeldey, Stockmair & Partner
Maximilianstrasse 58
W-8000 München 22(DE)

(54) Security system.

(57) A security system comprises an optical cable having at least one gap formed in the inside thereof to accommodate therein an optical fiber with an excessive length; a plurality of supports (1) having mandrels (2), one or more lines of the optical cable (3) being provided between the supports through the mandrels to provide a fence; a light transmitter (4) for applying an incident light to one end of the optical cable; and a light receiver (5) for receiving the light applied to the optical cable from the other end of the optical cable to detect a transmission loss of an optical signal;
wherein the optical cable (3) is formed so that when predetermined tension is applied to the optical cable, a predetermined transmission loss of the optical signal is generated in the optical cable.

FIG. 1



EP 0 509 537 A2

BACKGROUND OF THE INVENTION

(Field of the Invention)

The present invention relates to a security system using an optical fiber barrier for detecting an invader breaking into an area surrounded by the barrier.

(Prior Art)

Conventionally, as a security system, employed are an infrared camera, a system using infrared rays, or a method of transmitting an optical signal through an optical fiber.

An area which can be watched by one unit of such an infrared camera, a system using infrared rays, or the like, has a limit, resulting in difficulty to watch a wide area. On the other hand, a conventional system using an optical fiber is to detect whether the optical fiber is cut or not by a person. However, in the system, repair has been required to recover the system, and a large amount of optical fiber has also been used so that the person cannot invade an area surrounded by the optical fiber without cutting the optical fiber.

SUMMARY OF THE INVENTION

An object of the present invention is to solve the above problems accompanying the conventional systems, and to provide a security system in which wide area can be watched without optical fiber being damaged.

In order to solve the above problems, the present invention provides a security system which comprises an optical cable having at least one gap formed in the inside thereof so as to accommodate therein an optical fiber with an excessive length; a fence on which one or more lines of the optical cable are provided between supports through mandrels provided on the supports while winding around the mandrels; and a light transmitter for applying a light to one end of the optical fiber and a light receiver for receiving the light from the other end thereof to detect the transmission loss of an optical signal, respectively, wherein the optical cable is formed so that when predetermined tension is exerted to the optical cable, a predetermined transmission loss of the optical signal is generated in the optical cable.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an explanatory view of the whole configuration of the present invention;
Fig. 2 shows a sectional view of an optical cable applied to the present invention;
Fig. 3 shows a sectional view of another optical cable applied to the present invention;
Figs. 4a and 4b show sectional views of an optical fiber applied to the present invention, respectively;
Fig. 5 shows a view for explaining the principle of the present invention;
Figs. 6 and 7 shows views showing the measured values of the results obtained by the examples of the present invention, respectively; and
Fig. 8 shows a sectional view of an optical fiber applied to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described with reference to the accompanying drawings.

In Figs. 1 and 2, an optical cable 3 is provided with gaps 8 therein, and accommodates optical fibers 6, 6-2, 6-3, and 6-4 with an excessive length in the gaps 8, respectively. A plurality of supports 1 are provided with a plurality of mandrels 2 in such a manner that one or more lines of the optical cable 3 are arranged between the supports 1 through the mandrels 2 while winding around the mandrels 2 to form a fence. A light transmitter and receiver 4 and 5 applies an incident light to one end of the optical cable 3, and receives the light from the other end thereof, respectively.

The optical cable 3 is formed in such a manner that the optical fiber 6 is received in the gap 8 which is in the form of a linear or spiral groove provided in a surface of a stripe body 7, and a coating layer 9 is provided over the optical fiber 6.

The stripe body 7 is made of reinforced plastics including glass fibers, but a copper wire 10 may be used at a center of the stripe body 7 for increasing tensile strength.

The coating layer 9 is made of resin such as polyethylene, nylon, or the like. As shown in Fig. 3,

unevenness 11 is provided on an inner wall of the gap 8 so that microbent is easily generated in the optical fiber 6 when tension is exerted on the optical cable 3 which is bent by the mandrels 2.

It is preferable to provide three or more grooves 8 in one stripe body, so that any one of the optical fibers comes outside the bending radius of the optical cable 3 when the optical cable 3 is bent.

In an alternative method, as shown in Fig. 3, a marking or a structural groove location mark 15 is provided on a coating layer 9-1 at the position of a groove 8-1, whereby a cable is positioned so that the groove 8-1 is allowed to come to the outside of each mandrel 2.

Further, as shown in Fig. 4a, the optical fiber 6 is made such that solid particles 12 are mixed in a coating 13 of a glass fiber 14 so that microbent is generated easily. The solid particles 12 are made of spherical glass, fluorine resin, alumina, or the like. The size of the solid particles 12 is approximately 30 to 50μm, and the number thereof included in the coating 13 is approximately 50/mm. The same effect can be obtained if the solid particles 12 are attached to the outer surface of the coating 13 through an adhesive 21 as shown in Fig. 8, or if unevenness 22 is provided on the outer surface of the coating 13 as shown in Fig. 4b.

Similar to the coating layer 9, resin is used for the coating 13. In order to make the optical fiber 6 have excessive length, it is necessary to make the gap 8 larger than the outer diameter of the optical fiber 6. Alternatively, the gap 8 may be shaped so as to be elongated so that the excessive length of the optical fiber 6 may be given by the depth.

If a person intends to enter an area encircled by optical cables 3 arranged like a fence through a gap between optical cables 3, it is necessary to enlarge the distance between the optical cables 3 as shown in Fig. 5. Let the interval between supports 1-1 and 1-2 be L and let the enlargement of the distance between the optical cables 3-1 and 3-2 be Δa per optical cable, then the extension ΔL is expressed as in the following Equation (1).

$$\Delta L = (\sqrt{L^2 + 4\Delta a^2} - L)/L \quad (1)$$

On the other hand, the minimum length L_{MIN} which the optical fiber 6 can take in the gap 8 of the cable 3 is determined by the structure of the cable 3. For example, in a case of an optical fiber 6 in a groove 8 of a stripe body 7 longitudinally having a spiral groove, the minimum length L_{MIN} can be expressed by the following Equation (2) when the length of the cable 3, the pitch of the spiral groove, and the distance from the cable center to the groove bottom are represented by Lca, P and b, respectively.

$$L_{MIN} = L_{ca}\sqrt{P^2 + 4\pi^2 b^2}/P \quad (2)$$

In the case of a linear groove, L_{MIN} becomes equal to L_{ca}.

Further, discussion will be made on the case where an excessive length is given to an optical fiber received in the groove 8 so that the optical fiber is longer than L_{MIN} by ΔK. In this condition, the optical fiber 6 exists freely within the groove 8 without being subjected to lateral pressure. Then, if tension is applied to the cable by ΔL, the optical fiber 6 still has excessive length in a range of $\Delta L < \Delta K$, while lateral pressure F is applied to the optical fiber 6 from the groove bottom when condition becomes $\Delta L > \Delta K$. The lateral pressure F is expressed by the following Equation (3).

$$F = ES\frac{\Delta L}{L_{MIN}} \quad \cdots\cdots (3)$$

where, E, S and R represent the Young's modulus of the optical fiber 6, the sectional area of the optical fiber 6, and the radius of curvature of the optical fiber 6, respectively, the radius of curvature of the optical fiber 6 being determined by the spiral groove and satisfying the Equation of $R = b + (P/2\pi)^2/b$. Accordingly, the lateral pressure according to the present invention occurs with a threshold.

In the case where the radius of curvature R of the optical fiber 6 which is determined by the spiral groove is large, or in the case of a linear groove, there is a case where the lateral pressure effect cannot be sufficiently obtained. At this time, if mandrels 2 each having a small radius of curvature are attached to the supports 1 and the optical cable 3 winds around the mandrels 2 so that the groove 8 is directed toward the outer circumference of each of the mandrels 2, the lateral pressure effect becomes so large that optical fiber 6 is subjected to large lateral pressure to generate microbent, thereby increasing the transmission loss

of an optical signal.

On the other hand, in the case where the radius of curvature of each mandrel 2 is larger or in the case of using no mandrel 2, the force exerted on the cable 3 in a certain section may act onto the optical fiber 6 between the supports 1 in the adjacent section so that sufficient lateral pressure cannot be exerted onto the optical fiber 6 in the section in question. As measures to this, it is effective to provide such a structure that the optical fiber 6 is fixed with resin or the like in the groove 8 of the cable 3 at intervals substantially equal to those of the supports (preferably, at positions before or after a little from the respective supports 1.

The optical cables 3 shown in Figs. 2 and 3 are a concentric type that the copper wire 10 is positioned at the center of the cable, however, it may be of an eccentric type that the copper wire is displaced from the center of the cable, as shown in Fig. 8.

(Example 1)

In a cable structure shown in Fig. 3, an optical fiber 6-1 with an excessive length of 0.05% of the minimum length thereof was received in a spiral groove 8-1 to thereby form a cable 3. The cable 3 was attached on supports 1 provided at intervals of 2 m through mandrels 2 of 35 mm in diameter attached to the supports 1 in such a manner that the groove 8 was directed toward the outer circumference of each mandrel 2. Light of 1.55μm in wavelength was made incident into the optical fiber 6, and the cable 3 at the intermediate portion between the supports 1 was displaced by from 0 to 50mm while the quantity of light reception was being detected at the other end of the optical fiber 6. As shown in Fig. 6, the loss caused by the displacement of the cable 3 and the microbent in the optical fiber due to the displacement of the cable 3 did not change to increase in a range of 0 to 35mm of the displacement, while it showed a tendency of increase relative to the displacement beyond the above range.

(Example 2)

Four optical fibers 6, 6-2, 6-3 and 6-4 were received in respective spiral grooves under the conditions similar to those in the Example 1 to form a cable 3 as shown in Fig. 2, and similar measurement was performed. As a result, as shown in Fig. 7, the optical fiber 6 had a tendency of increase similarly to the Example 1 while no increase of loss occurred in the other three optical fibers 6-2, 6-3 and 6-4. This was considered that only the optical fiber 6 was attached in the radially outer side of the mandrel 2.

In the security system according to the present invention, the change of loss shows a behavior with a threshold depending on the force exerted to the cable or the quantity of expansion of the distance between the cable portions, because there exist a case where the optical fiber is subjected to lateral pressure and a case where it is subjected to no lateral pressure. Accordingly, in only the case where sufficient large force is exerted the system can perform detection of the optical loss while it does not operate against a fine displacement of the cable due to wind pressure, temperature change, or the like.

Claims

1. A security system comprising:
   an optical cable having at least one gap formed in the inside thereof to accommodate therein an optical fiber with an excessive length;
   a plurality of supports having mandrels, one or more lines of said optical cable being provided between said supports through said mandrels to provide a fence;
   a light transmitter for applying an incident light to one end of said optical cable; and
   a light receiver for receiving the light applied to said optical cable from the other end of said optical cable to detect a transmission loss of an optical signal; and
   wherein said optical cable is formed so that when predetermined tension is applied to said optical cable, a predetermined transmission loss of the optical signal is generated in said optical cable.

2. A security system as claimed in Claim 1, wherein said optical cable comprises a stripe body, a linear groove formed in a surface of said stripe body to constitute said gap, and a coating layer provided over said optical fiber.

3. A security system as claimed in Claim 1, wherein said optical cable comprises a stripe body, a spiral groove formed in a surface of said stripe body to constitute said gap, and a coating layer provided over said optical fiber.

4. A security system as claimed in Claim 1, wherein said gap has an inner wall with unevenness.

5. A security system as claimed in Claim 1, wherein said gap comprises three or more linear grooves longitudinally formed in each of three portions of said optical cable.

6. A security system as claimed in Claim 2, wherein said gap comprises three or more spiral grooves longitudinally formed in each of three portions of said optical cable.

7. A security system as claimed in Claim 2, wherein said gap comprises one linear groove formed in one portion of said optical cable, and a groove location mark is provided on said cover at a position of said linear groove.

8. A security system as claimed in Claim 3, wherein said gap comprises one spiral groove formed in one portion of said optical cable, and a groove location mark is provided on said coating layer at a position of said spiral groove.

9. A security system as claimed in Claim 7, wherein said optical cable is arranged so that the position of said groove location mark is adjusted to make said gap come to the outside with respect to the radial direction of said mandrel.

10. A security system as claimed in Claim 8, wherein said optical cable is arranged so that the position of said groove location mark is adjusted to make said gap come to the outside with respect to the radial direction of said mandrel.

11. A security system as claimed in Claim 1, wherein said optical fiber comprises a glass fiber and a coating layer surrounding said glass fiber, said coating layer containing particles therein.

12. A security system as claimed in Claim 1, wherein said optical fiber comprises a glass fiber and a coating layer covering said glass fiber, said coating layer having unevenness on an outer surface thereof.

13. A security system as claimed in Claim 1, wherein said optical fiber is fixed in said groove at intervals substantially the same as those of said supports.

14. An optical cable in use for a security system, comprising:
an optical fiber;
a stripe body having at least one gap into which said optical fiber is received; and
a coating layer for covering said stripe body together with said optical fiber.

15. An optical cable as claimed in Claim 14, further comprising a copper wire inserted in said stripe body for increasing tensile strength of said optical cable.

16. An optical cable as claimed in Claim 14, wherein said gap comprises a linear groove.

17. An optical cable as claimed in Claim 14, wherein said gap comprises a spiral groove.

18. An optical cable as claimed in Claim 14, wherein said gap comprises one groove, and a groove location mark is provided on said coating layer at a position of said groove.

19. An optical cable as claimed in Claim 14, wherein said coating layer contains a plurality of solid particles.

20. An optical cable as claimed in Claim 14, wherein said coating layer has an outer surface thereof with unevenness.

21. An optical cable as claimed in Claim 14, further comprising a plurality of solid particles attached to an outer surface of said coating layer.

FIG. 1

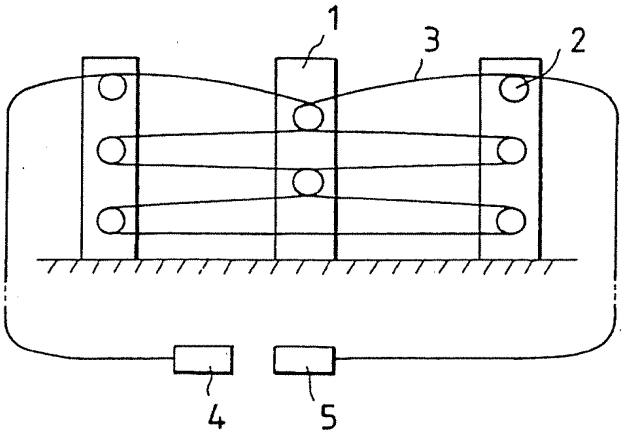


FIG. 2

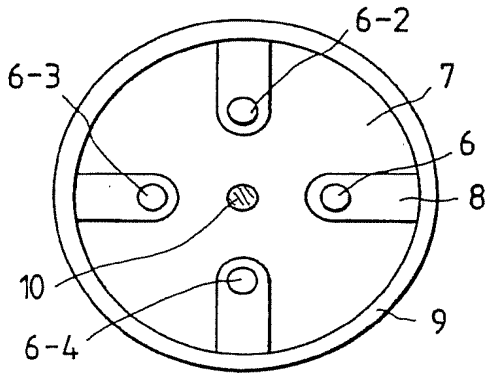


FIG. 3

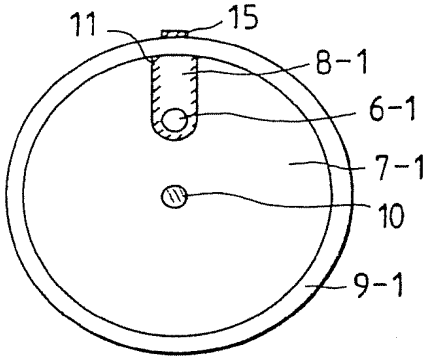


FIG. 4a

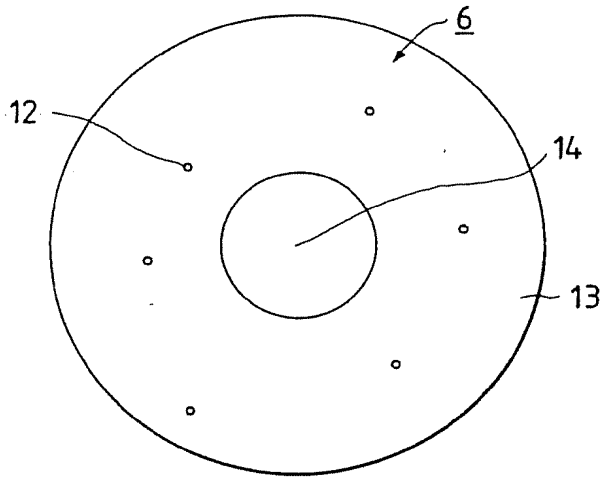


FIG. 4b

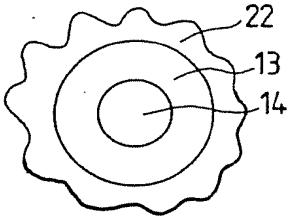


FIG. 5

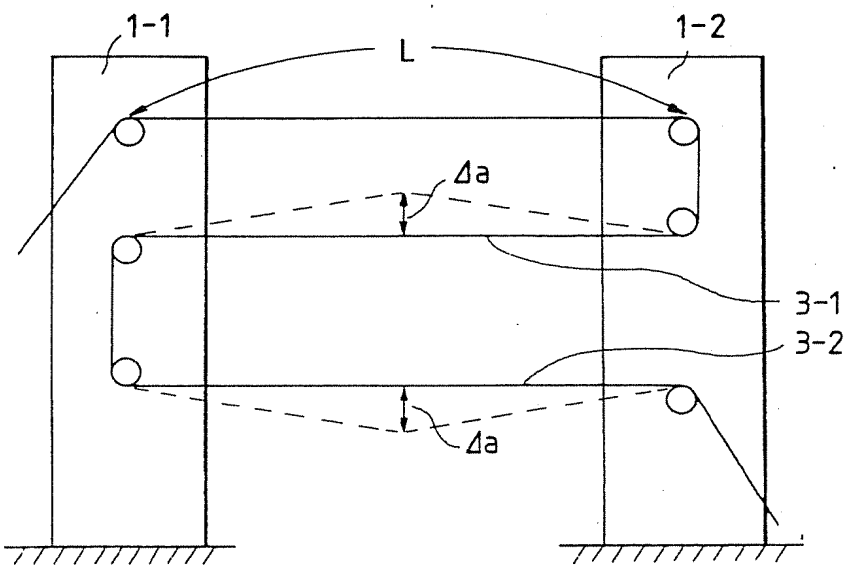


FIG. 6

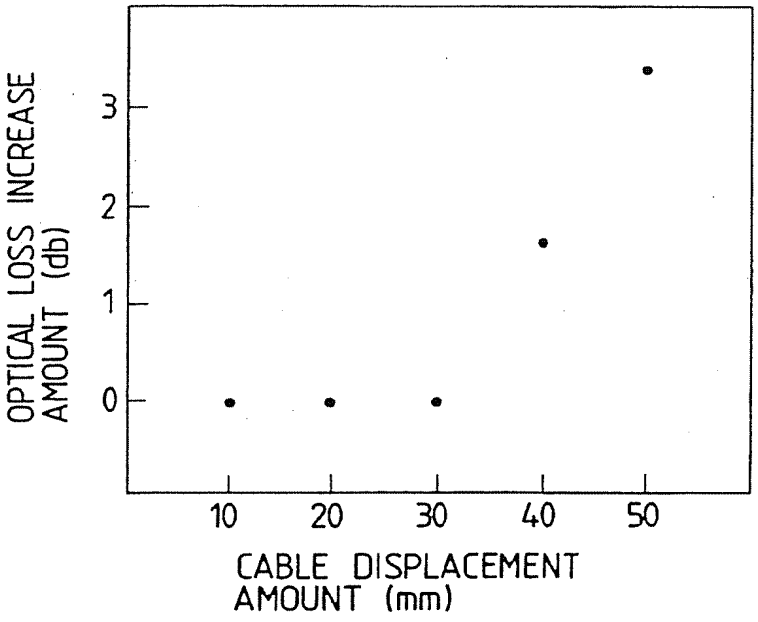


FIG. 7

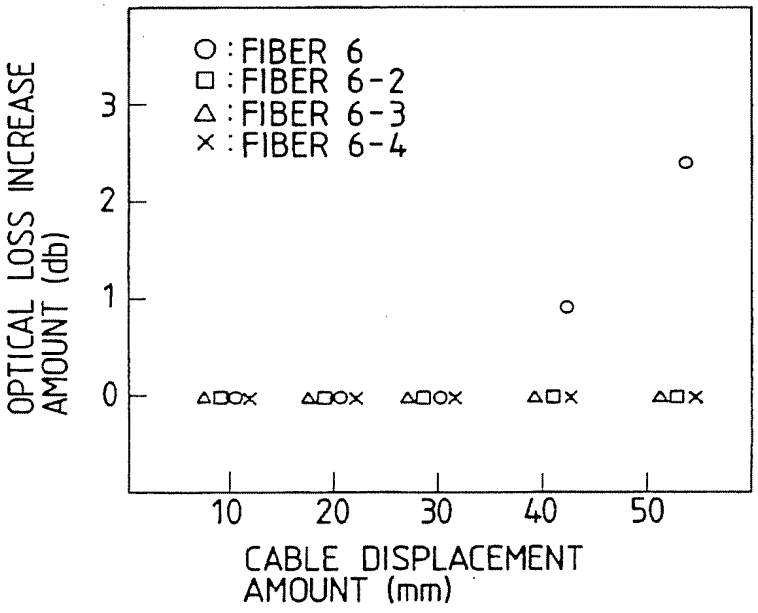
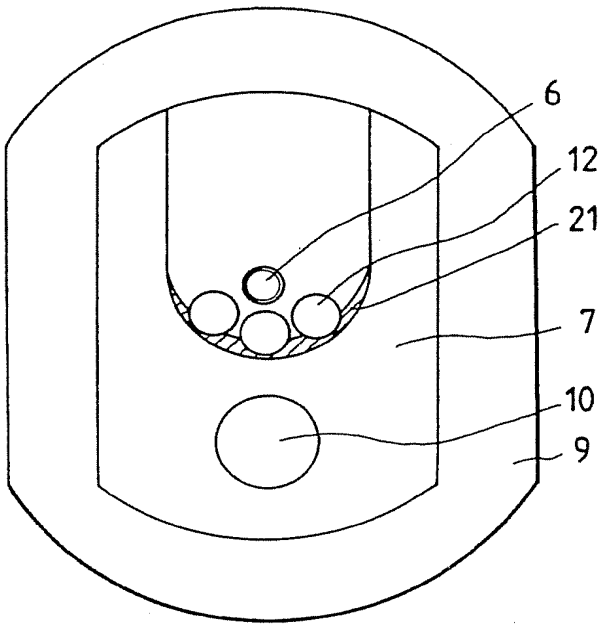


FIG. 8



(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 509 537 A3**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 92106688.2

(51) Int. Cl.5: G02B 6/44, G08B 13/186

(22) Date of filing: 16.04.92

(30) Priority: 16.04.91 JP 84151/91
07.04.92 JP 84294/92

(43) Date of publication of application:
21.10.92 Bulletin 92/43

(84) Designated Contracting States:
DE GB

(88) Date of deferred publication of the search report:
03.02.93 Bulletin 93/05

(71) Applicant: SUMITOMO ELECTRIC INDUSTRIES, LTD.
5-33, Kitahama 4-chome, Chuo-ku
Osaka-shi, Osaka 541(JP)
Applicant: MATSUSHITA ELECTRIC WORKS, LTD.
1048, Oaza-Kadoma
Kadoma-shi Osaka 571(JP)

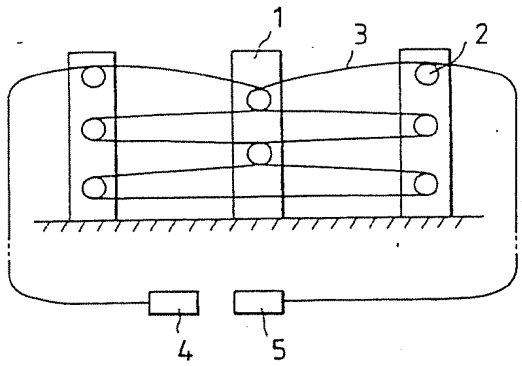
(72) Inventor: Ohta, Junichi, c/o Yokohama Works of Sumitomo
Electric Industries, Limited, 1, Taya-cho
Sakae-ku, Yokohama-shi, Kanagawa(JP)
Inventor: Wakami, Toshinori, c/o Yokohama Works of Sumitomo
Electric Industries, Limited, 1, Taya-cho
Sakae-ku, Yokohama-shi, Kanagawa(JP)
Inventor: Okamoto, Kazuhiro, c/o Yokohama Works of Sumitomo
Electric Industries, Limited, 1, Taya-cho
Sakae-ku, Yokohama-shi, Kanagawa(JP)
Inventor: Miki, Ryusuke, c/o Matsuhita Electric Works Ltd.
1048, Oaza Kadoma
Kadoma-shi, Osaka(JP)
Inventor: Kanbe, Yoshiaki, c/o Matsuhita Electric Works Ltd.
1048, Oaza Kadoma
Kadoma-shi, Osaka(JP)

(74) Representative: Patentanwälte Grünecker, Kinkeldey, Stockmair & Partner
Maximilianstrasse 58
W-8000 München 22(DE)

(54) Security system.

(57) A security system comprises an optical cable having at least one gap formed in the inside thereof to accommodate therein an optical fiber with an excessive length; a plurality of supports (1) having mandrels (2). one or more lines of the optical cable (3) being provided between the supports through the mandrels to provide a fence; a light transmitter (4) for applying an incident light to one end of the optical cable; and a light receiver (5) for receiving the light applied to the optical cable from the other end of the optical cable to detect a transmission loss of an optical signal;
wherein the optical cable (3) is formed so that when predetermined tension is applied to the optical cable, a predetermined transmission loss of the optical signal is generated in the optical cable.

FIG. 1



EP 0 509 537 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 6688

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	PATENT ABSTRACTS OF JAPAN vol. 9, no. 179 (M-399)24 July 1985 & JP-A-60 049 200 (HITACHI DENSEN KK) 18 March 1985 * abstract *	1	G02B6/44 G08B13/186
Y	EP-A-0 196 510 (CI.KA.RA. S.P.A.) * abstract; figure 1 * * column 2, line 25 - line 42 *	1	
Y	US-A-4 701 614 (JAEGER ET AL.) * abstract; figures 1,2,4 * * column 3, line 50 - line 68 *	14	
A	*Idem*	11,19,21	
Y	FR-A-2 494 452 (LES CABLES DE LYON, S.A.) * page 2, line 18 - line 21; figures 1,2 * * page 2, line 34 - page 3, line 1 *	14	
A	*Idem*	17	
A	GB-A-2 174 822 (FUJIKURA LTD.) * abstract; figures 1-3 * * page 2, line 22 - line 26 *	2,3,5,6	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 246 (P-393)3 October 1985 & JP-A-60 100 003 (HITACHI DENSEN KK) 3 June 1985 * abstract *	4,12	G02B G08B
A	GB-A-2 039 683 (FIBUN BV.) * page 2, line 34 - line 54; figures 1,3 *	1	
A	FR-A-2 551 253 (LIGNES TELEGRAPHIQUES ET TELEPHONIQUES-LITT (S.A.)) * page 3, line 16 - line 24; figure 2 *	2,3	

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	02 DECEMBER 1992	DANIELIDIS S.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 6688

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB-A-2 179 072 (STC PLC) * page 2, line 107 - line 126; figures 7,8 * ---	14,15	
A	EP-A-0 246 487 (MAGAL SECURITY SYSTEMS, LTD.) * abstract; figures 6A,6B * * column 6, line 47 - line 53 * ---	4,12, 14-20	
A	GB-A-2 123 164 (STANDARD TELEPHONES AND CABLES PUBLIC LIMITED COMPANY) * abstract; figures 4,6 * ---	15	
A	FR-A-2 583 528 (FOPTICA) * page 5, line 25 - line 29; figure 1 * ---	16	
A	GB-A-2 158 963 (TELEPHONE CABLES LTD.) * abstract; figure 4 * ---	18	
A	GB-A-2 187 305 (BICC PLC.) * abstract; figure 1 * ---	18	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	FR-A-2 418 506 (COMPAGNIE GENERALE D'ELECTRICITE S.A.) * page 2, line 27 - line 30; figure 3 * -----	20	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	02 DECEMBER 1992	DANIELIDIS S.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)

European Patent Office

EP92106688

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.

☐ Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid.

namely claims:

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

X LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions.

namely:

1. Claims 1-13: Security system
2. Claims 14-21: Construction of optical cable

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid.

namely claims:

☐ None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims.

namely claims: